... the only thing we have to fear is fear itself.

—Franklin D. Roosevelt

That famous phrase was uttered in the midst of a banking crisis in 1933, a situation not entirely unlike the one investors faced in 2008. A recounting of the events of 2008 would be highly redundant at this point, but the experience of 2008 allows us to twist President Roosevelt’s statement into an interesting question. If the only thing to fear is fear itself, can fear in turn be a good defense against fear? Enter the VIX.

The Chicago Board Options Exchange (CBOE) Market Volatility Index, or VIX, was conceived in 1993 by Professor Robert E. Whaley of Duke University to provide a benchmark of expected short-term volatility. According to the CBOE: “VIX measures 30-day expected volatility of the S&P 500 Index. The components of VIX are near- and next-term put and call options, usually in the first and second S&P 500 Index (SPX) contract months.”

As will be demonstrated below, the value of volatility itself lies in the fact that it is negatively correlated to the returns of the equity market and becomes increasingly so as market declines accelerate. As a result, long exposure to volatility could provide increasing levels of portfolio protection exactly when investors are most in need of such protection. Another way to think about this is that because most investors are net long equities, they are implicitly short volatility, and therefore hedging that exposure may be prudent.

The theoretical knowledge and empirical understanding of implied volatility, as defined by the VIX, was put into play in 2004 when VIX futures began trading, followed in 2006 by the creation of options on the VIX. In 2009, Barclays Capital launched exchange-traded notes (ETNs) that track VIX futures contracts. The development of ETNs on the VIX has special relevance for the private wealth management industry. While institutional investors regularly use derivative instruments, the ability of financial advisors to use futures, options, or swaps often is greatly limited, if not precluded, when working with high-net-worth individuals. The reasons vary but include a host of operational considerations, a lack of familiarity with derivatives at the advisor level, and/or reluctance of individual investors to allocate capital to exotic structures. The availability of an ETN solves these problems, although as we will see, not without introducing other issues.

An evaluation of these ETNs and the volatility index on which they are based sought answers to the following questions:

- What is the nature of equity volatility?
- What are the characteristics of the VIX and does it adequately capture true volatility?
- Are VIX futures and related ETNs in turn able to harness the qualities of the VIX, or is something lost in translation?
- What would an allocation to volatility as an asset class bring to a diversified portfolio?

But before addressing these questions, let’s delineate the primary difference between volatility and other asset classes. Unlike a share of stock, a bond, or an ounce of gold, volatility has no intrinsic value. As such, over time the expected return to this mean-reverting measure will be equal to the cost of attaining exposure. In other words, long-term exposure to volatility is simply a cost, a drag on portfolio per-

... The truly long-term investor, who isn’t negatively impacted by short-term volatility, has no reason to bear such a cost; but for the rest of us, volatility may prove a useful allocation.

The Nature of Equity Volatility

Figure 1 shows a few interesting features of volatility. For one, the downside is truncated. Unlike other assets, volatility cannot go to zero, and over the past three decades it has spent little time below 10 percent. In addition, volatility is not normally distributed; it has
exceedingly fat tails, as indicated by high kurtosis (i.e., peakedness of the distribution). Finally, it is itself highly volatile and positively skewed, making long exposure to volatility quite beneficial to investors.

As indicated, figure 1 shows actual thirty-day volatility, selected to correspond to thirty-day implied volatility as measured by the VIX. Additionally, a review of the S&P 500 returns distribution is informative. From figure 2 we see that daily returns for the S&P 500 are also nonnormal, that is, fat tails exist (even if the scale prevents us from seeing them). But unlike thirty-day volatility, this distribution is negatively skewed. Further, the maximum daily loss has been roughly twice the size of the maximum daily gain, which is something to keep in mind as we examine the VIX.

**Does the VIX Adequately Capture True Volatility?**

It is impossible to invest in volatility directly, so the above analysis of the volatility of the S&P 500 is instructional but not particularly useful in practice. The VIX gets us one step closer to investing in volatility, but the VIX suffers from the same problem: One cannot invest directly in the VIX because it is not a tradable index. Before exploring products that attempt to generate returns dependent on the VIX, let’s determine whether the VIX captures the positive hedging characteristics of actual volatility.

To do that, let’s consider the transmission mechanism by which equity volatility impacts the VIX. Whaley (2008) and Siegel (2007) both discuss this mechanism, which is that, when equity markets are falling, the demand for both out-of-the-money and at-the-money put options increases, driving up the price of those options and, concurrently, implied volatility. Siegel (2007) also points out that arbitrageurs who sell puts also must sell stocks in order to hedge their positions and remain delta-neutral. The more puts they sell, the more stocks they sell, which may make a selloff worse and increase the negative correlation between implied volatility and equities.
Figures 3 and 4 show the closing level and the daily return distribution, respectively, of the VIX going back to 1990. As is the case with actual volatility, the series is mean-reverting, the downside is truncated, the distribution is nonnormal, and it is positively skewed.

While considering the return distribution of the daily changes of the VIX, recall the return profile of the S&P 500 presented in figure 2. The best single day for the S&P 500 going back to 1950 was +11.6 percent and its worst one-day loss, suffered in October 1987 on Black Monday, was −20.5 percent. While the worst one-day loss on the VIX is similar in magnitude at −25.9 percent, the best single day for the VIX was +64.2 percent. The return profile for the VIX is indeed asymmetrical, and that asymmetry can be demonstrated by comparing a scatter plot of rolling thirty-day returns on the S&P 500 to rolling thirty-day returns on the VIX (shown with a second-order polynomial trend line in figure 5.)

As figure 5 shows, the line’s slope is steepest when the S&P 500 is deep in the red, but flattens out as equities post positive returns. What does this tell us? When it is most needed, that is, when the equity markets are falling dramatically, the delta, or rate of change on the VIX is the greatest. This type of profile allows for a small commitment of capital to provide meaningful protection to a portfolio, which we will explore below.

But does the VIX capture actual volatility in a meaningful way? As option traders are acutely aware, implied volatility almost always is higher than actual subsequent volatility, up until the moment when actual volatility spikes. It is for this reason that selling naked options has been likened to picking up nickels in front of a steam roller—it works and it’s easy right up until the moment you get run over. Small win ... small win ... small win ... big loss, is not an attractive return profile for most investors.

While implied volatility almost always is higher than actual subsequent thirty-day volatility (see figure 6), the
correlation between the two series is high at 0.73. But if we are considering using VIX exposure as a hedge, we aren’t particularly concerned with the ability of the VIX to forecast future volatility (and that’s not a question that a simple correlation analysis can answer in any event). What we are concerned with is both the correlation and sensitivity between the daily changes in the S&P 500 and the daily changes in the VIX. By regressing the VIX on the price changes of the S&P 500 we calculated the statistics in Table 1 on both a daily and a monthly basis.

These statistics confirm that the return profile to the VIX is quite different in bull (up) markets than in bear (down) markets. The correlation statistics become more negative during down markets and the beta statistics increase, and the down market capture ratios are greater than the up market capture ratios. These relationships are exactly what we’d like to see in a hedging vehicle.

One final point remains regarding the VIX and its mean-reverting ways: The regression analysis revealed that the strongest link between the starting point on the VIX and subsequent returns was around the five-year mark. This means that if an investor were able to invest in spot VIX and hold that position for five years, the return to that investor largely would be dictated by the starting level of volatility. This can be thought of in terms similar to the relationship between the starting valuation level for the equity market and subsequent equity returns. Table 2 demonstrates this point by showing the level of the VIX at that time of a hypothetical investment and the subsequent five-year return on that investment.

The takeaway here is that the payoff to volatility is greatest when it is in effect cheapest, that is, when market participants are complacent and risk seeking. Once the markets are in the midst of a selloff and market participants are scared stiff, the expected payoff to VIX exposure turns negative, providing yet another instance where being contrarian pays off.

Can VIX Futures and Related ETNs Harness VIX Qualities?
Volatility as an asset class has attractive features that could allow it to be an effective hedge against negative equity outcomes. Furthermore, while the VIX is intended to reflect expectations of future near-term volatility, it does a more than adequate job of capturing changes to actual volatility as those changes occur. The question remaining is whether futures based on the VIX, and in turn the ETNs, will convey similar advantages to investors.

The lack of history on which to make a meaningful analysis, however, creates a problem. The Barclays’ ETNs were launched in January 2009 and provide little more than a year of data. Even so, the ETNs are based on futures contracts and futures have been trading on the VIX since late 2004, so the analysis begins with those futures contracts.

Like all futures contracts, VIX futures have a term structure. That term structure is typically in contango when volatility is stable or low and moves to
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**Figure 8: VIX Futures Term Structure as of October 15, 2008**

Backwardation* when volatility is high. Figure 7 shows the term structure of the VIX as of March 31, 2010; a time when volatility was subdued and the futures were in contango. During such periods, rolling the futures contracts results in a significantly negative roll yield; specifically, buying higher-priced, longer-dated futures contracts, settling them at lower prices as they approach maturity, and rolling the proceeds into yet another longer-dated futures contract, results in a loss.

However, in times of high volatility such as October 2008, the term structure likely will be in backwardation (see figure 8) and investors will earn a positive roll yield as contracts are rolled forward.

This concept of roll yield adds to the earlier discussion about the starting level on the VIX and subsequent returns. In times of high volatility the roll yield is positive, but the expected return on the VIX turns negative. In times of low volatility the expected return on the VIX turns positive, but the roll yield is negative, and maintaining such a position becomes expensive.

To explore what that cost might look like over time, consider a theoretical portfolio of spot VIX versus a hypothetical portfolio of VIX futures contracts. Barclays Capital provided an index series representing a hypothetical VIX futures portfolio managed on the same basis as the iPath S&P 500 VIX Short Term Futures ETN (ticker: VXX; gross of fees). Figure 9 shows the growth in value of these two hypothetical portfolios.

Here the story, so far so promising, starts to fall apart. Recall that an investor cannot invest in spot VIX, so the theoretical portfolio value is merely a reference point for judging how well a futures portfolio captures the theoretical returns to spot VIX. Yet a constant futures position fails to deliver spot-VIX returns. In figure 9, the annualized return to spot VIX was almost 17 percent and the annualized return to the futures portfolio was approximately 22 percent. That nearly 40-percent annualized differential is due primarily to the roll yield. To a lesser degree, the differential also reflects the difference in the time periods of the two series: The VIX reflects implied volatility in the near-term and next-term options contracts while the VIX futures are priced according to future expectations for implied volatility. For example, a three-month VIX futures contract measures the implied volatility on the S&P 500 Index that is expected in three months' time. This time discrepancy is the reason that VIX futures exhibit lower volatility than spot VIX.

In defense of the cost of rolling futures contracts, Barclays pointed out that roll yield is similar to the time decay (theta) of put options and claimed that the roll yield is lower than the implied realized premium in put options.

Further, because of the term structure of VIX futures, Barclays offers two different ETNs. The short-term VIX ETN (VXX) is based on the one- and two-month futures contracts, whereas the medium-term VIX ETN (VXZ) is based on the four- and seven-month futures contracts, both of which are managed with a daily roll methodology. Because the mid-range of the term structure is flatter roll costs are minimized, and in a low volatility environment when the roll yield is in contango, investors are better off in VXZ. The downside to VXZ is lower beta relative to VIX. Barclays calculates that the highest beta of VIX
futures relative to actual VIX is in the one-month and two-month contracts, or 0.5 and 0.35, respectively. That beta decreases with maturity, so VXX is best when volatility spikes.

Due to the issues explored above, the return profiles for VXX and VXXZ will differ materially from the VIX. Consider the daily change in the price of VXX relative to the daily change in VIX since inception of the ETNs (see figure 10).

Figure 10 shows that the daily differential typically is large; in fact, the average differential is 2.5 percent on an absolute basis. Further, as discussed above, the beta of VXX to VIX is far below 1.0. The calculation of the beta of VXX to VIX on a daily basis is 0.47. Even so, VXX is highly correlated to VIX; the correlation between the daily price changes is around 0.86.

What can we conclude from this analysis? The VIX itself has attractive characteristics that make it an effective hedging tool, but the futures contracts—and the ETNs in turn, are less-compelling for investors who want to buy and hold what is effectively portfolio insurance. Holding the position long-term results in a direct cost of 89 basis points for the ETNs (which is the stated expense ratio for the notes), and more importantly, a materially negative roll cost.

A first thought about how to deal with this issue was to come up with a simple trading strategy based on the level of the VIX when a position was initiated. For example, one could take a full position in VXX or VXXZ when volatility was near one standard deviation below the mean, virtually ensuring a positive expected return to volatility given the mean-reverting tendencies. That position could be pared as VIX reached its mean, then exited at one standard deviation above the mean, when expected returns are negative. However, as discussed earlier, the term structure of the VIX results in the highest roll costs during periods of low volatility, and while volatility is mean-reverting, it can take years for mean reversion to occur, a wait that can put a drag on an investor’s portfolio. More-intricate trading models based on shorter time frames could work, although the necessity to implement such trades detracts significantly from the use of these types of products (ETNs) within the private wealth management industry. Alternatively, positions could be added whenever an advisor believes that a volatility spike is likely, such as around major macro events; this would be effective, but unfortunately not all major market crises have an observable ramp-up ex ante. Advisors wishing to utilize these ETNs will be injecting significant timing risk into their use. Ultimately, ETNs are not appropriate for buy-and-hold investors, though they react favorably when truly needed.

**What Would an Allocation to Volatility Bring to a Diversified Portfolio?**

An investment in the VIX through ETNs is too costly to be practical as a strategic allocation to a portfolio. An investment in spot VIX is only theoretical. But finance is an ever-changing industry and more optimal ways of harnessing the VIX may come along.

Every asset added to a portfolio should serve at least one of two purposes: return enhancement or risk reduction, which are relative. Strategies that use hedging techniques typically provide risk reduction for an equity-heavy portfolio but return enhancement to a fixed-income-heavy portfolio. Many strategies used by hedge funds (and used increasingly by hedge-fund-like mutual funds) try to reduce systematic risk (e.g., equity risk, credit risk, interest-rate risk) within their portfolios but do not directly offset those same risks elsewhere in an investor’s portfolio. For example, an equity-market-neutral fund may not introduce any equity beta into a portfolio, but it doesn’t offset the equity beta that comes from a large-capitalization growth manager in the portfolio. To protect a portfolio against large losses in times of market stress, an investor needs a direct hedge, i.e., an asset that is negatively correlated to other assets in the portfolio. Volatility is just such an asset.

A series of efficient frontiers using forward-looking return and risk expectations was constructed, with the goal of being realistic about the risk and return characteristics of the hypothetical VIX position, because exposure to any asset has a cost. In this case, for simplicity’s sake, assume that the return expectation to the VIX is −0.89 percent, which mirrors the explicit cost to the VIX ETNs (but importantly ignores the roll cost). Even with a negative expected return, inclusion of the VIX improves efficiency. Figure 11 shows that an efficient frontier constructed of basic asset classes, i.e., domestic stocks, bonds, and
cash, can be improved by adding a VIX position. The improved efficient frontier improves more when constructed using a complete asset class set that includes a greater variety of assets ranging from domestic stocks to emerging market debt to bank loans in addition to the VIX. Note that a small allocation to the VIX can have a big impact. The portfolio labeled BG&I (a balanced growth and income portfolio) has an expected return of 6.85 percent with expected volatility of 10.5 percent. A 3.5-percent allocation to the VIX at the expense of the equity exposure (i.e., BG&I + 3.5% VIX) decreases expected return by 30 basis points but decreases risk by 216 basis points, a valuable tradeoff.

Comparing a basic 60/40 portfolio with the "BG&I" and "BG&I + 3.5% VIX" portfolios shows how including the VIX affects Value at Risk® and loss probability. Figure 12 presents two sets of calculations, those labeled "End of Horizon," which are concerned solely with the ending value for the stated time frame, and those labeled "Within Horizon," which calculate the worst outcome at a specified probability from the beginning to any point during the stated time period.

Including a small allocation of capital to the VIX has a noticeable impact (see figure 13), especially on the decrease in the probability of a loss of 5 percent or greater over a one-year horizon (on a continuous basis). A 60/40 portfolio has a 46-percent chance of a loss of 5 percent or more, whereas the BG&I + 3.5% VIX has only a 28-percent chance of such a loss.

Conclusion

Volatility as an asset class is compelling. It is negatively correlated to the returns of the equity markets, and the negative correlation increases as market declines accelerate. As a result, long exposure to volatility could provide increasing levels of portfolio protection exactly when investors most need such protection. The asymmetric profile provided by volatility means that a relatively small allocation of capital can provide meaningful protection.
However, the benefit to volatility erodes as its characteristics are transferred from actual volatility to implied volatility to futures on implied volatility, and finally to ETNs based on the futures on implied volatility. In the end, what appeared to be a powerful diversifying tool for strategic asset allocators ends up being appropriate only to express shorter-term views on volatility.

What other options does an investor have? The use of dedicated short managers can be effective in mitigating total volatility, and many fund-of-hedge-fund managers do just that. However, the return profile tends to be more linear with the return to the equity market. That is, a 4-percent decline in the S&P 500 likely would result in a 4-percent return to a dedicated short manager with at least enough skill to offset fees. But the asymmetric return profile of the VIX cannot be matched by short managers.

Another possibility is, of course, equity options. But Szado (2009) demonstrated that VIX calls provide a more efficient means of diversification than S&P puts. Further, Jacob and Rasiel (2009) made the following observations about buying options:

“Options have exposure not just to volatility, but also to market direction. To maintain directional neutrality requires frequent updating of a delta hedge position on the underlying asset. Options are a wasting asset... Therefore, options cannot be included as an asset in a buy-and-hold portfolio.”

Finally, what about hedge funds in general? We advocate including hedging strategies in a portfolio to complement long-only equity and fixed income managers. However, while many strategies used by hedge funds seek to reduce systemic risk (e.g., equity risk, credit risk, interest-rate risk) within their own portfolios, that risk reduction does not directly offset those very same risks contained elsewhere in an investor’s portfolio. Equity beta coming from the large-capitalization growth manager is not offset by the hedged equity position within a convertible arbitrage strategy.

Given these findings regarding the VIX ETNs, as well as the limitations of other potential investments as true hedges against market crises, the search for the holy grail of hedging for strategically allocated portfolios must continue. In the absence of a perfect hedging vehicle, investors should continue to rely on tried-and-true measures of risk mitigation. First and foremost, know what you are investing in and why, thoroughly evaluate the risk and return characteristics of each investment, and properly balance those characteristics in order to achieve the desired results. Be realistic in forecasting return expectations, and recognize that risk management is about the probability of being wrong as well as the magnitude of the loss. Second, diversify broadly. Go beyond the naïve approach, which can be greatly improved upon through proper portfolio construction in which asset allocation and manager selection are utilized as separate and distinct tools to solve different problems. Investors utilizing these principals have been well-served over time (2008 notwithstanding), and likely will reap the rewards of doing so in the future.

Clifford W. Stanton, CFA*, is chief investment officer for Prima Capital Holding, Inc. Contact him at cstanton@primacapital.com.

Endnotes
1 Before 2004, options strategies and variance swaps were used to capture exposure to volatility.
2 Symbols: VXX and VIXZ
3 Note that the time periods of these two return distributions differ: S&P 500 data go back to 1950 whereas VIX data begin in 1990.
4 The time period over which the calculations were made is January 1990–February 2010.
5 Contango is a term used in the futures market to describe an upward-sloping forward curve.
6 Backwardation is a term used in the futures market to describe a downward-sloping forward curve.
7 Source: Chicago Board Options Exchange
8 VaR is the maximum likely loss over the indicated time period at the 95-percent confidence level.

References